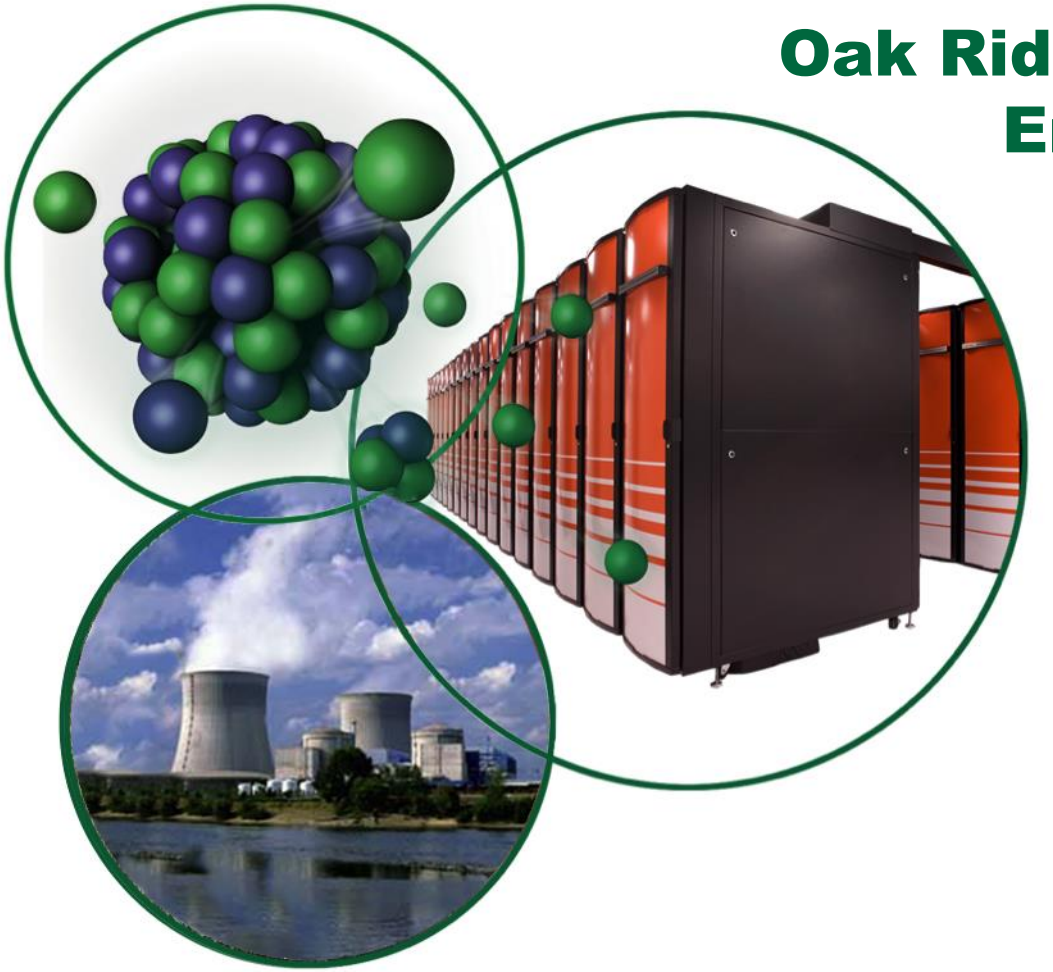
DOE Office of Electricity Energy Storage
Imre Gyuk, Program Manager
2014 Peer Review
Oak Ridge National Laboratory
Energy Storage Program



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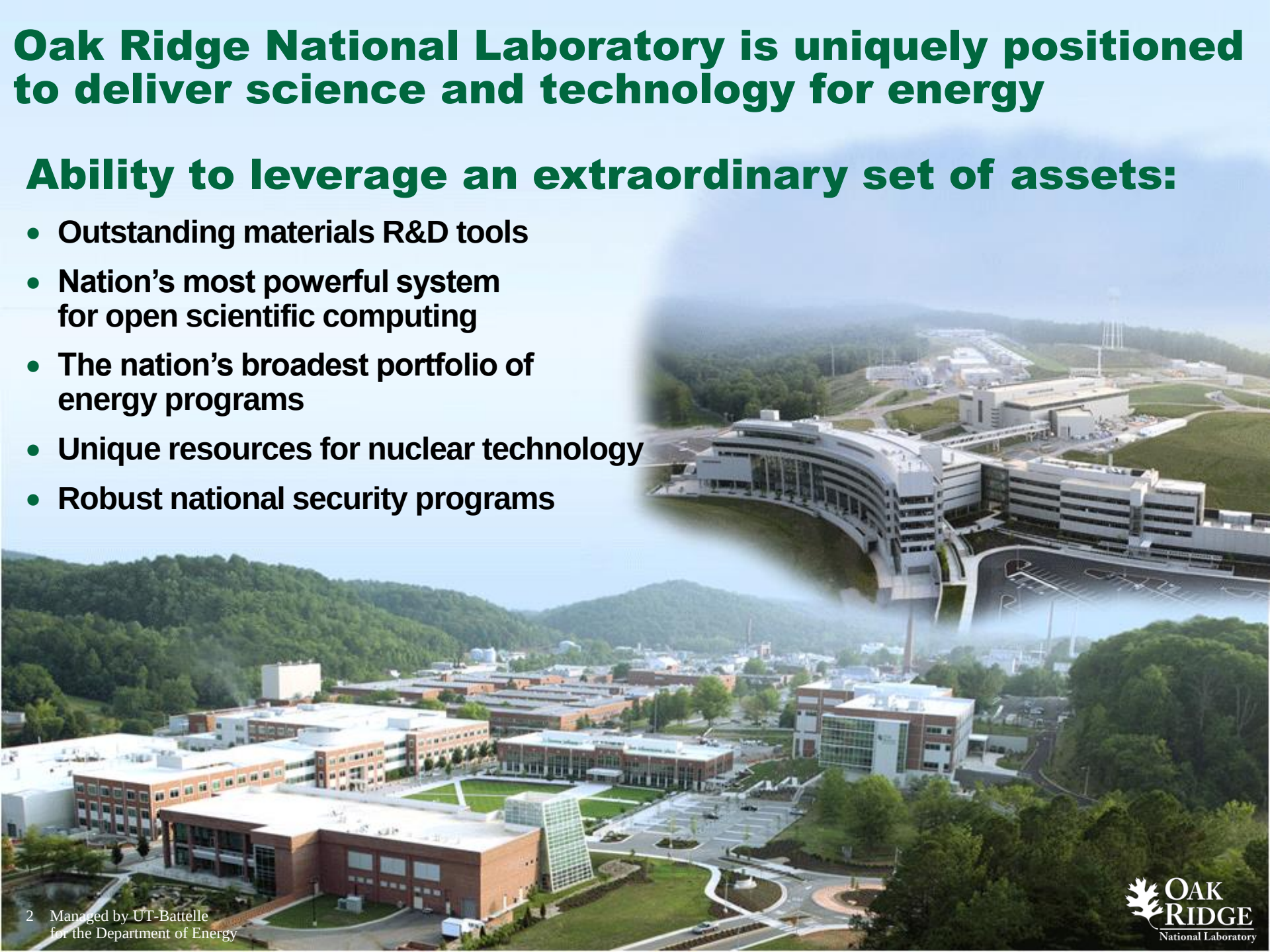
Oak Ridge National Laboratory is uniquely positioned to deliver science and technology for energy

Ability to leverage an extraordinary set of assets:

- Outstanding materials R&D tools
- Nation's most powerful system for open scientific computing
- The nation's broadest portfolio of energy programs
- Unique resources for nuclear technology
- Robust national security programs



OAK RIDGE National Laboratory

Lower Cost Carbon Fiber for Flywheels, ORNL

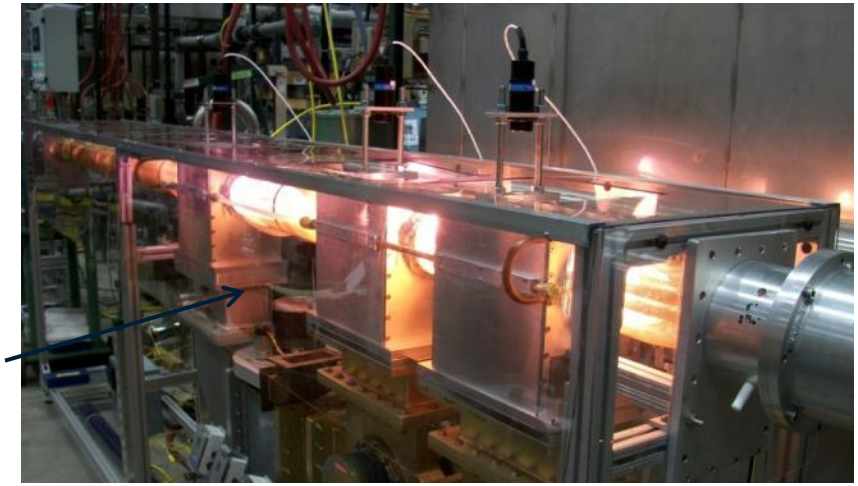
Reduce cost of high performance carbon fiber for flywheel applications via leveraging $50M DOE investment in carbon fiber technology facility

Description

- Reduce Carbon fiber material cost to enhance proliferation of flywheel-based energy storage for frequency regulation.

Carbon Fiber Technology Facility (CFTF)

Microwave-assisted-plasma carbonization tightly controls energy levels



FY14 Accomplishments

- Demonstrated capabilities at CFTF to exceed minimum targets for facility and industry competitive properties with commercial precursor.
- Demonstrated new microwave assisted plasma carbonization approach ready to scale to CFTF.
- Measured baseline mechanical properties for ORNL filament wound composite material representative of industry flywheel rims.

FY15-16 Plans

- Expand industry collaboration to implement ORNL LCCF materials in flywheels.
- Develop and Process industry selected mechanical properties for additional composite materials.
- Characterize carbon fibers under development and project performance/economic tradeoffs for flywheels
- Apply ORNL surface treatment technology to increase composite strength critical to flywheels

EESR Electrical and Electronics Systems Research Division

OAK RIDGE National Laboratory

Low Cost Lithium-Sulfur Batteries for Electric Grid Applications, ORNL

Description

- Overcome problems of conventional Li-S batteries by replacing flammable liquid electrolytes with nonflammable solid electrolytes
- Develop, test, and validate large format Li-S batteries with solid electrolytes.

Megaton storage of S

- **Performance**
- **Cost**
- **Safety**

Solid-state Li-S batteries are expected to be high performance, low cost, and intrinsically safe

FY14 Accomplishments

- Discovered high-conductivity of sulfide-based solid electrolytes
- Synthesized Li-ion conducting polysulfide cathode materials.
- Demonstrated cyclability of all-solid Li-S batteries in coin-cell format

FY15-16 Plans

- Scale up synthesis of solid electrolytes.
- Validate solid electrolyte electrochemical properties.
- Optimize lithium-ion conducting polysulfide based cathode compositions for all-solid-state Li-S batteries
- Assemble 2” x 2” pouch cells based on results of ½ inch coin cells

EESR Electrical and Electronics Systems Research Division

OAK RIDGE National Laboratory

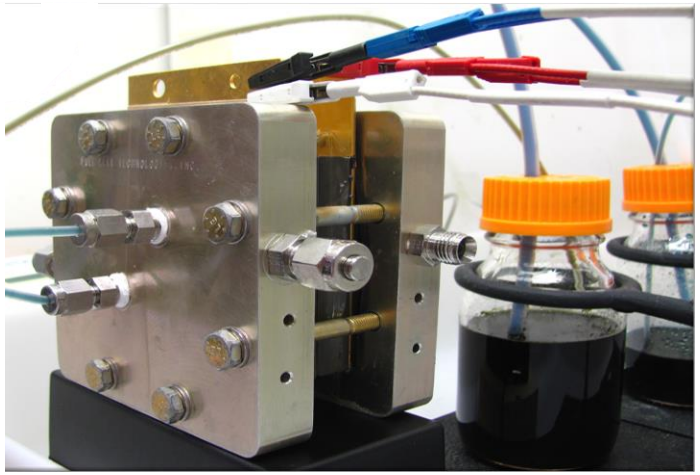
Redox Flow Batteries, ORNL, UTenn

Description

Increase performance of RFBs, lower costs, and provide tools and data to industry for development of grid-scale batteries:

1) Produce novel electrodes with enhanced kinetics and mass transport
2) Develop a membrane database characterizing key parameters,
3) Foster participation and adoption of cell materials in the industrial supply chain.

HP VRFB Performance



Max power density : **2588mW/cm^2**; Max current density : **5033mA/cm^2**

FY14 Accomplishments

- Demonstrated improved VRFB cell performance.
- Demonstrated cycling of VRFB with 80% round trip voltage efficiency @ 500 mA/cm^2
- Demonstrated membrane improvements iterating iterating for improved durability.
- Developed new testing approaches to investigate electrode durability.

FY15-16 Plans

- Improve cycle life and performance of VRFB.
- Develop comprehensive diagnostics for durability.
- Develop, demonstrate new membrane and electrode materials with improved performance.
- Complete licensing & spin out HP VRFB technology.
- Expand effort to include other high performance battery chemistries.

EESR Electrical and Electronics Systems Research Division

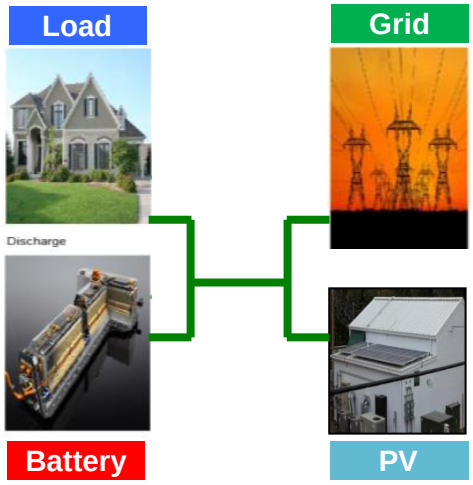
OAK RIDGE National Laboratory

Distributed Energy Storage (DES)
EV Battery Second-Use, ORNL

Develop paths for secondary applications of EV batteries on the grid

Description

- Develop paths for secondary use of EV batteries on the grid.
- Test and validate applications that potentially demonstrate a positive business case.
- Evaluate and optimize multiple value streams.



Secondary-Use Energy Storage System and PV Integration/Testing at ORNL

FY14 Accomplishments

- Developed control architecture for demonstrating various grid related services for distributed energy storage systems.
- Completed first year testing of distributed energy storage using secondary-use system for various single applications.

FY15-16 Plans

- Complete large scale electrical distribution model to examine value proposition impact of DESS aggregation in five US regions.
- Develop agnostic interface to secondary-use energy storage system considering variations in battery voltage, power, and size.
- System year-long testing demonstrating multiple applications and value streams.

EESR Electrical and Electronics Systems Research Division

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